5-1990

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Degree Type

Thesis

Degree Name

Master of Science in Vision Science

Committee Chair

Diane P. Yolton

Subject Categories

Optometry

THE BACTERICIDAL EFFECTIVENESS OF LID SCRUB PRODUCTS AGAINST STAPHYLOCOCCUS AUREUS

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A thesis submitted to the faculty of the
College of Optometry
Pacific University
Forest Grove, Oregon
for the degree of
Doctor of Optometry
May, 1990

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Biographical Sketches

Court R. Wilkins attended the University of Utah in Salt Lake City, Utah. Upon completion he was awarded a Bachelor of Science degree in Biology and a minor in Chemistry and Japanese. After receiving the O.D. degree, he will be serving with the United States Army Medical Corp. and will be stationed in Berlin, Germany.

Kurtis K. Hill attended Ricks College in Rexburg, Idaho and later transferred to Brigham Young University where he received a Bachelor of Science degree in Agricultural Economics. After receiving the O.D. degree, he will serving with United States Air Force Medical Services for three years at Hickam, AFB in Hawaii. He plans on returning to the state of Washington to start a private practice with an emphasis in primary care optometry.

Acknowledgements

We would like to thank Dr. Lori Rynd of Pacific University's Biology department for supplying us with equipment used to run our experiments. We would also like to thank Pacific University College of Optometry for supplying equipment and a facility to perform our experiments. Special thanks to Dr. Diane Yolton for her hours of consultation in the planning and seeing the whole project through.

Abstract

Chronic blepharitis secondary to Staphylococcus aureus infection is a very common ocular disorder. Part of the treatment for this condition is to have the patient cleanse the lid margin with a soap/detergent product on a Q-tip, gauze pad or cloth. The purpose of the cleansing is to mechanically remove bacteria along with toxic or irritating substances produced during the infection. The traditional lid cleansing product is baby shampoo. Recently new lid scrub products such as I-Scrub, OcuSoft, and Medmoor Eyelid Cleanser have been introduced. Although most detergents are bactericidal, baby shampoo and these new cleansers have not been assessed for this property. Therefore, we determined the bactericidal action of these products by mixing samples of these cleansers with S. aureus and determined how many bacteria were killed. All the products showed bactericidal activity against S. aureus.

Introduction

Chronic blepharitis is one of the most common ocular disorders in humans.[1] The most common type of blepharitis is bacterial infection of the lid margin with S. aureus or S. epidermidis.[2] Subjective complaints consist of foreign body sensation, lids stuck together upon awakening, itching, tearing and burning.[2] Objective signs include crusts surrounding the lashes or on the lid margin and erythema of the lids.[3] Complications consist of superficial punctate keratopathy, madarosis, trichiasis, thickened lid margins, corneal marginal infiltration/ulceration, or phyctenulosis.[4] Blepharitis can also make the adaptation to contact lenses extremely difficult, aggravate or slow the treatment of keratitis sicca or endanger intraocular surgery.

There is no absolute or definitive treatment for chronic blepharitis. However, the mainstay of treatment is careful lid hygiene including hot compresses and lid scrubs. Lid scrubs consist of cleansing the lid margin with a soap/detergent product on a Q-tip, gauze pad or cloth. Cleansing the lids with lid scrubs will decrease the bacterial count and remove the

crusts and bacterial products that surround the lashes. The traditional cleansing product that is used for lid scrubs has been baby shampoo in varying dilutions, but recently other cleansers have become commercially available. These new cleaners have been shown to have equal or better clinical effectivenes as baby shampoo.[5]

Part of the effectiveness of the lid scrub cleansers is through the mechanical cleaning process which removes bacteria along with toxic and irritating bacterial products. Another part of the effectiveness of these products is due to the killing of bacteria. All the products have detergent properties and detergents are known to have bactericidal properties.[6] However, the bactericidal properites of these products have not been directly assessed. Therefore, it was the purpose of this project to determine the bactericidal effectiveness against S. aureus of four commonly prescribed lid scrub products: Johnson's Baby Shampoo (Johnson & Johnson), I-Scrub (Spectra Pharmaceutical Services), OcuSoft Lid Scrub (OcuSoft), and Ultra-Mild Eyelid Cleanser (Medmoor). S. aureus was exposed to each product and the number of bacteria killed determined.

Materials/Methods

The strain of S. aureus used was a control culture obtained from the laboratory of Tualatin Hospital. Upon receiving the culture it was maintained in an active state by replating on tryptic soy agar (TSA) every few days during the experimentation. The lid scrub products, OcuSoft, Medmoor, I-Scrub were obtained directly from the distributor and baby shampoo was obtained from the local supermarket. Baby shampoo is frequently diluted before being used during the lid cleansing. To mimic this, we used three different concentrations, concentrated baby shampoo, a dilution of 1:5 baby shampoo to saline and another dilution of 1:10 baby shampoo to saline.

The length of time the S. aureus was exposed to each product was 3 minutes. This time period was selected to mimic the approximate time a patient would use the lid scrub at a single application.

Each experiment was initiated by growing S. aureus in tryptic soy broth for 24 hours. After 24 hours, 1 ml from the broth culture was transferred into a tube containing 9 ml of tryptic soy broth and grown for approximately 6 hours. The bacteria were washed twiced with sterile saline and diluted to an estimated 10^6 bacteria/ml by using serial dilutions. This mixture was then diluted 2 or 3 more times resulting in

three starting concentrations. The number of bacteria in each starting concentration was determined by plating samples on TSA. The plates were incubated for 24 hours and then the number of colonies were counted on each plate to determine the number of bacteria in each starting concentration. These numbers were used to determine initial number of bacteria in the bacteria/product mixtures.

To determine the bactericidal effect of the lid scrub products, 0.1ml from each of the three starting concentrations was mixed with 0.9 ml of lid scrub product. The mixture was quickly vortexed to mix the bacteria and product thoroughly and then left for three minutes. After three minutes 0.1ml of the mixture was plated on two TSA plates. The bacteria were grown for 24 hours and then the number of colonies that grew on each plate were counted. Each colony grew from one bacterium and so the number of live bacteria could be recorded. The kill rate was determined by taking the initial number of bacteria in the mixture, subtracting from it the viable number of bacteria left after three minutes and then dividing the difference by the initial number of bacteria. As a control 0.1ml of each initial concentration was mixed with 0.9 ml of saline for 3 minutes and then plated.

Results

The experiment was run a total of six times. In three of the attempts the numbers were unreliable and therefore were not incorporated into our results. The three usable runs will be called experiments #1, 2 & 3.

In experiment number one, starting concentrations of bacteria in the bacteria/product mixtures were $3x10^4$, $3x10^3$ and $2x10^2$ per ml. The range of percent kill varied from 0% to 99% (Table 1).

Table 1. Bactericidal Effect of Lid Scrub Products: Experiment #1

Initial concentration	$3x10^4$		$3x10^3$		$2x10^2$	
PRODUCTS	Viable Bact.	% kill	Viable Bact.	% kill	Viable Bact.	% kill
Saline	Uncountable	--	$2x10^3$	33%	$2x10^2$	0%
I-Scrub	$0.5x10^4$	83%	$0.7x10^3$	77%	$2x10^2$	0%
Ocusoft	$0.01x10^4$	99%	$0.02x10^3$	99%	$1x10^2$	55%
Medmoor	$0.03x10^4$	99%	$0.02x10^3$	99%	$<0.2x10^2$	99%
B. Shampoo	$0.003x10^4$	99%	$<0.3x10^3$	99%	$<0.2x10^2$	99%
B.S. 1:10	$0.01x10^4$	99%	$0.01x10^3$	99%	$<0.2x10^2$	99%
B.S. 1:5	$0.01x10^4$	99%	$0.01x10^3$	99%	$0.5x10^2$	78%

In experiment number two the initial concentrations of bacteria were about 10 fold higher: $1x10^5$, $1x10^4$ and $4x10^3$ per ml. The range of percent kill varied from 22% to 98% (Table 2).

Experiment number three the initial concentrations were $2x10^5$,

$2x10^4$ and $3x10^3$ per ml. The range of percent kill varied from 27% to 99% (Table 3).

Table 2. Bactericidal Effect of Lid Scrub Products: Experiment #2

Initial concentration	$1x10^5$		$1x10^4$		$4x10^3$	
PRODUCTS	Viable Bact.	% kill	Viable Bact.	% kill	Viable Bact.	% kill
Saline	Uncountable	--	$0.9x10^4$	9%	$4x10^3$	0%
I-Scrub	Uncountable	--	$0.6x10^4$	52%	$3x10^3$	22%
Ocusoft	$0.08x10^5$	93%	$0.05x10^4$	95%	$0.2x10^3$	95%
Medmoor	$0.09x10^5$	92%	$0.2x10^4$	95%	$0.3x10^3$	93%
B. Shampoo	$0.04x10^5$	97%	$0.1x10^4$	88%	$0.08x10^3$	98%
B.S. 1:10	$0.05x10^5$	95%	$0.2x10^4$	81%	$0.2x10^3$	96%
B.S. 1:5	$0.09x10^5$	92%	$0.3x10^4$	73%	$0.4x10^3$	90%

Table 3. Bactericidal Effect of Lid Scrub Products: Experiment #3

Initial concentration	$2x10^5$		$2x10^4$		$3x10^3$	
PRODUCTS	Viable Bact.	% kill	Viable Bact.	% kill	Viable Bact.	% kill
Saline	Uncountable	--	$2x10^4$	0%	$3x10^3$	0%
I-Scrub	Uncountable	--	$1x10^4$	48%	$2x10^3$	27%
Ocusoft	Uncountable	--	Uncountable	--	$0.3x10^3$	87%
Medmoor	Uncountable	--	$0.9x10^4$	65%	$0.5x10^3$	80%
B. Shampoo	$0.2x10^5$	99%	$0.2x10^4$	91%	$0.2x10^3$	94%
B.S. 1:10	Uncountable	--	$0.9x10^4$	60%	Contaminated	--
B.S. 1:5	Uncountable	--	Uncountable	--	$0.9x10^3$	65%

If the bactericidal effectiveness of each product is assessed across

the experiments with the number of starting bacteria in the bacteria/product mixture ranging from $3x10^4$ to $2x10^2$, the following results are obtained. I-Scrub lid cleanser had a range of percent kill from 0% to 83% (Table 4); OcuSoft lid cleanser, a range of 55% to 99% (Table 5); Medmoor lid cleanser, a range of 65% to 99% (Table 6); baby shampoo, a range of 88% to 99% (Table 7); baby shampoo diluted 1:5, a range of 60% to 99% (Table 8); and baby shampoo diluted 1:10, a range of 65% to 99% (Table 9).

Table 4:
Bactericidal Effect of I-Scrub

Viable Bacteria		
Start	End	% kill
$3x10^4$	$0.5x10^4$	83%
$2x10^4$	$1x10^4$	48%
$1x10^4$	$0.6x10^4$	52%
$4x10^3$	$3x10^3$	22%
$3x10^3$	$2x10^3$	27%
$3x10^3$	$0.7x10^3$	77%
$2x10^2$	$2x10^2$	0%

Table 5:
Bactericidal Effect of Ocusoft

Viable Bacteria		
Start	End	% kill
$3x10^4$	$0.01x10^4$	99%
$1x10^4$	$0.05x10^4$	95%
$4x10^3$	$0.2x10^3$	95%
$3x10^3$	$0.02x10^3$	99%
$3x10^3$	$0.3x10^3$	87%
$2x10^2$	$1x10^2$	55%

Table 6:
Bactericidal Effect of Medmoor

Viable Bacteria		
Start	End	% kill
$3x10^4$	$0.03x10^4$	99%
$2x10^4$	$0.9x10^4$	65%
$1x10^4$	$0.2x10^4$	83%
$4x10^3$	$0.3x10^3$	93%
$3x10^3$	$0.02x10^3$	99%
$3x10^3$	$0.5x10^3$	80%
$2x10^2$	$<0.2x10^2$	99%

Table 7:
Bactericidal Effect of Baby Shampoo

Viable Bacteria		
Start	End	% Kill
$3x10^4$	$0.003x10^4$	99%
$2x10^4$	$0.2x10^4$	91%
$1x10^4$	$0.1x10^4$	88%
$4x10^3$	$0.08x10^3$	98%
$3x10^3$	$<0.3x10^3$	99%
$3x10^3$	$0.2x10^3$	94%
$2x10^2$	$<0.2x10^2$	99%

Table 8:
Bactericidal Effect of Baby Shampoo, 1:5 Dilution

Viable Bacteria		
Start	End	% Kill
$3x10^4$	$0.01x10^4$	99%
$2x10^4$	$0.9x10^4$	60%
$1x10^4$	$0.2x10^4$	81%
$4x10^3$	$0.2x10^3$	96%
$3x10^3$	$0.01x10^3$	99%
$2x10^2$	$<0.2x10^2$	99%

Table 9:
Bactericidal Effect of Baby Shampoo, 1:10 Dilution

Viable Bacteria		
Start	End	% kill
$3x10^4$	$0.01x10^4$	99%
$1x10^4$	$0.3x10^4$	73%
$4x10^3$	$0.4x10^3$	90%
$3x10^3$	$0.9x10^3$	65%
$3x10^3$	$0.1x10^3$	99%
$2x10^2$	$0.5x10^2$	77%

Discussion

All of the lid scrub products were bactericidal, which was not surprising. When the ingredients of the products were analyzed as to the content and chemical make up, each product was essentially a mild soap with some detergent properties.[6] Detergents have a definite bactericidal activity.[6] Detergents are more effective against gram-positive organisms, such as S. aureus. and less effective against gram-negative ones.[7] They are effective in concentrations as low as one part in several thousand parts of water.[7] Detergents are able to penetrate the cell wall and disrupt the cell membrane thus killing the bacteria.[8]

Soaps have limited antimicrobial properties killing only a few specific species which include Streptococcus, Neisseria, Treponema and influenza virus.[9] Their primary purpose is to aid in mechanically removing microbes from surfaces by solubilizing oils and greases on the skin (with associated bacteria) so that they are more easily washed away.[8] This is useful in breaking up the crust and oil build-up secondary to staphylococcal blepharitis.

Under our experimental conditions, all of the lid scrub products

killed S. aureus. Baby shampoo in its concentrated form appeared to have the highest and most consistent percent kill while I-Scrub seemed to have the lowest and most inconsistent percent kill. There was not an increased kill rate with a decrease in the number of starting bacteria with any of the products. These results indicate that all lid scrub products have antibacterial properties that would contribute to the effectiveness of lid scrubs for the treatment of staphylococcal blepharitis.

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